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Smart contracts reduce mental transaction costs

In my old essay on micropayments and mental transaction costs, besides pointing out that mental transaction costs were a far more important barrier to Internet micropayments than computational transaction costs, I sketched some ideas for tools to lower mental transaction costs. Lowering mental transaction costs enables pricing at finer granularity, which increases price-sensitive behavior and thus the efficient allocation of scarce resources. I also used electricity conservation as a practical example of how mental transaction costs pose a barrier to price flexibility and thus to conservation. It turns out that electricity conservation is among the first areas to benefit from smart contracts that lower mental transaction costs.

This paper I presented at the Second Berlin Internet Economics Workshop in 1999 provides more detail on the economic theory behind mental transaction costs. Basically, mental transaction costs are the "hassle factor" one experiences when spending money: the costs of translating one's own knowledge and preferences into buying decisions. Mental transaction costs pose a severe limit on the efficiency of markets in general and on useful price granularity in particular; they are the main reason consumers generally prefer flat-rate pricing and why high price granularity (and thus micropayment) is usually useless.

Tools to lower mental transaction costs have vast potential but present many problems, especially "determining what the parties want in the first place." The most promising tools are smart contracts -- computerized devices that respond to the environment according to price signals or other contractual terms, customer preferences, and other states or events that are encoded in them or that they are encoded to respond to. Many smart contracts in the future may be programmed using a contract drafting language for specifying their event-driven behavior.

(I have also emphasized making smart contracts securely self-enforcing or self-verifying, but that is a different topic from this post, which deals with the role of smart contracts in lowering mental transaction costs).

Mental transaction costs pose a barrier to any scheme to go from flat rate to variable pricing in order to conserve resources. Such a scheme may be made possible only by technological or institutional breakthroughs which lower mental transaction costs. Faruqui and Earle[1]'s description of California's Demand Response scheme for peak-demand pricing of electricity is generally a good description of a successful and promising program that increases conservation and reduces the danger of blackouts by going from flat pricing to three price tiers (off-peak, peak, and critical peak). But the article fails to recognize the important role of mental transaction costs when increasing the number of price tiers. The authors do, however, recognize two important success factors. The importance of these factors provides strong evidence that mental transaction costs and tools that save on these costs will crucial in determining the scope and success of California's demand-sensitive pricing scheme. The authors observed that "[o]n average, residential customers reduced

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peak loads on critical days by 13.1 percent." The reduction was much larger for customers with central air conditioning. More interesting still, customers with "automatic price-sensitive thermostats" saved twice as much energy as customers that did not have these smart contract devices.[2]

The first effect comes about because on average each central air unit consumes far more power than each window unit; correspondingly the same mental transaction costs expended in controlling the thermostat of the former saves far more energy and thus money than controlling the latter. The second effect comes because the price-sensitive thermostat is a specialized smart contract that allows for simple input preferences (a simple table of preferred temperature at each of three to five price levels depending on the contract) and then runs automatically. It thus fulfills (for this particular function) my hopes of using simple user interfaces to input preferences into smart contracts which then make purchases automatically, thereby reducing the the mental transaction costs otherwise imposed by multi-tier pricing.

In its most general form, a smart contract will have a market translator that specifies a purchasing or selling action based on a function of current budget, environmental variables, and current and predicted (e.g. according to rational expectations models) prices:

transaction_decision = f(preferences, budget, environment, prices, price model)

That general description makes it all rather complicated; in practice there will be quite simplified versions based on simple versions of a subset of these variables that work in particular niches where those variables dominate preferences. An example of this simplicity is the "automatic price-sensitive thermostats" mentioned above. Programming this thermostat is only a bit more complicated than a normal thermostat: one programs in multiple temperatures each corresponding to a price level. For example, at an off-peak charge of 9 cents/kilowatt*hour, the summer air conditioning thermostat might be set to 72 degrees, while the normal peak price of 22 cents might be set to 74 degrees and the critical peak price (the hottest days when California would without substantial conservation otherwise be in danger of blackout) of 60 cents set to 77 degrees. So you input three settings instead of one. Presumably when you want to change the settings you can do it one at a time or change all three at a time by the same amount. That takes substantially more effort than a normal thermostat, but the California experiment showed that where the overall use controlled by that thermostat is great enough and the price differential high enough, it's worth the effort.

A bit more generally, a preference for physical state of the world can be specified by specifying a function

preferred_state = f(current price)

The thermostat then, like any thermostat, purchases electricity based on the function

if actual_state > preferred_state ***then*** purchase (turn on consumption)
else don't purchase (turn off consumption)

(Reverse to "<" when heating rather than cooling and analogously for other kinds of physical states). The most typical example is the thermostat where the desired state has one dimension (temperature), but one can think of other desired states such as illumination patterns (also tied to current electricity prices), high network bandwidth and low latency applications such as video on demand, and so on which are multidimensional. Where price granularity is small and discontinuous (as in the three-tier price scheme described above) a simple table is probably the lowest mental transaction cost way of inputting the preferences. Where the price changes continuously, a simple graphical interface with a touch-sensitive cursor to define the price/state curve may be the best option, but realize that the transaction costs for the latter may be far larger than the former for the typical user, and so justified only when the value of resources conserved by price is much greater.

Offline References:

[1] Ahmad Faruqui and Robert Earle, "Demand Response and Advanced Metering," *Regulation* v. 29 n. 1 (Spring 2006).

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[2] Id. at pg. 25.

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